used to acquire the kinetic information. Diffusion in the gold/nickel-iron system in the temperature range 600 to 950°C was found to be by a combined lattice and grain boundary mechanism. Under typical atmospheric conditions, with relatively low moisture contents, the manganese impurity in the substrate segregated and oxidized at the surface of the gold and thus reduced contact sticking. Under similar low moisture conditions, annealing of nickel-iron in the absence of gold did not produce the segregation/depletion phenomenon. In this case, depletion only occurred at much higher moisture contents. A minimum in the failure rate of reed contacts corresponded with a peak in surface manganese content.

In a related contribution, C. A. Haque of Bell Laboratories, Columbus, Ohio, reported upon studies of the diffusion of electroplated layers of gold and silver by Auger spectroscopy and electron spectroscopy for chemical analysis. From 660 to 800°C, substrate diffusion was minimal, the silver/gold ratio was relatively low and the sticking tendency was high. On heating above about 800°C, there was considerable diffusion of iron, nickel and manganese from the substrate to the surface, together with an increase in the silver/gold ratio. Base metal oxides which formed decreased the tendency of the surfaces to stick. If oxide thickness (particularly in the case of nickel oxide) became excessive, contact resistance increased, which is another failure mode of reed relays.

T. Dabrowska and W. Francyk of the Technical University of Wroclaw, Poland, compared the contact behaviour of rhodium-against-rhodium reed relay contacts with that of contacts in which one blade was coated with rhodium and the other with gold. Contact resistance and metal transfer were determined during operation. It was found that the gold-against-rhodium configuration was superior to the all-rhodium system. The direction of current flow also affected contact resistance and it was better to make the gold contact positive. Erosion resistance was, however, better when opposite polarity was used.

Fretting corrosion takes place when base metals rub against each other over small amplitudes, of the order of tens of μm. Resistive oxide films quickly develop in the wear track. This can occur with electrical components due to differential thermal expansion and contraction of contact members or due to vibration. G. J. Caule and D. Gyuria of Olin Corporation, New Haven, Connecticut, studied this effect with a variety of copper alloys. The most stable material was, as expected, that of their control sample made of electrodeposited gold, 150 μm in thickness.

A New Gold-Cadmium Electrodeposit

R. T. Hill and K. J. Whitlaw of Lea Ronal, U.K. presented the results of a study of a new acid cyanide gold electrodeposit containing one per cent cadmium and one per cent of other elements, identified in their presentation as the components of 'intrinsic polymer'. Deposits had contact resistance stability on heating at 125°C for 1 000 hours which was superior to that of pure gold. Hardness was 130 to 180 kg/mm^2. Low porosity deposits were readily obtained. The adhesive wear behaviour was comparable to that of a cobalt-hardened gold. A study of gold-cadmium deposits was published in *Gold Bull.,* 1978, **11**, (2), 43-48.

The Proceedings of Contacts/1978 can be obtained from the Dept. of Electrical Engineering, Illinois Institute of Technology, Chicago, Ill. 60616, U.S.A.

Gold Electrodeposits Solve an Unusual Wear Problem

In automatic wrist watches which operate through movement of the wearer's arm, problems may arise due to the rubbing action between the hardened steel spring and its brass housing. If small wear particles of brass detach and enter the watch mechanism they interfere with its running and can even cause complete stoppage.

Since, for technical reasons, changes in the base materials used are not acceptable, an obvious answer to this difficulty was to plate the spring housing with a wear-resistant coating of suitably low coefficient of friction. After numerous trials, the choice for this purpose was a hard gold alloy electrodeposit (GALVATRONIC) developed by Werner Flühmann AG of Duebendorf in Switzerland, and which had for many years been well established as a superior coating for sliprings and contacts of all types (*Gold Bulletin,* 1976, **9**, (1), 11). The alloy composition is 75 gold/22 copper/3 cadmium weight per cent. Electrodeposit hardness is between 380 and 450 HV with a typical tensile strength of 910 MPa and an elongation of 5 per cent. Moreover, it has a single phase unordered structure and a sharp texture with more than 90% of {111} planes parallel to the surface. These features, together with its very small average grain size (27 Å) and excellent tribological properties make it better suited for the application than a metallurgically prepared 18 carat gold alloy of similar composition.

Hence, the spring housings in a Swiss watch of world-wide repute are currently plated with 1.5 μm of this hard gold. This results in an equilibrium between abrasion and repolishing (healing) effects so that over very long periods practically no loose metal is produced by friction between the spring and its housing.

W.F.F.